INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

FLIGHT MECHANICS								
IV Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED09	**Core**	3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Fluid Dynamics								

I. COURSE OVERVIEW:
Flight mechanics is the science that investigates the performance of the aircraft as applied to flight vehicles and to provide a clear understanding of related topics, specifically on aerodynamics, propulsion, performance, stability and flight controls. The course introduces the fundamental principles of aerodynamics and propulsion for aircraft performance in classical flying stages. This course is the point of confluence of other disciplines with aeronautical engineering and the gateway to aircraft design.

II. COURSE OBJECTIVES:
The students will try to learn:
I. The fundamental principles of aerodynamics and propulsion for aircraft performance in classical flying stages.
II. The different regimes of aircraft and performance requirements at various atmospheric conditions.
III. The mathematical models for various types of maneuvers, safety requirements during takeoff, landing for better performance and stability.
IV. Longitudinal and directional parameters with the help of the linearized equations of aircraft motion.

III. COURSE OUTCOMES:
After successful completion of the course, students will be able to:
CO 1 Demonstrate the mission profiles of simple cruise, commercial transport and military aircrafts for getting the airplane performance characteristics.
CO 2 Explain the cruise performance of an airplane in relation with range and endurance with different types of aircraft engines.
CO 3 Develop the aircraft man oeuvre performance to perform in turn, pull-up and pull-down man oeuvres by considering limitations of power for military and civil aircrafts
CO 4 Compare the various landing distances such as discontinued landing, bulk landing for better stability and control of the aircraft.
CO 5 Examine the different types of dynamic modes in longitudinal, lateral and directional motion for the aircraft and their influence on dynamic stability and safety.
CO 6 Apply the advance theories of flight dynamics in design of modern control airplane control systems for enhancing aircraft performance, Modern control systems and autopilot system

IV. COURSE CONTENT:
MODULE-I: INTRODUCTION TO AIRCRAFT PERFORMANCE (10)
The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air

data computers; Equations of motion for performance - the aircraft force system; Total airplane drag-estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.

MODULE –II: CRUISE PERFORMANCE (09)

Maximum and minimum speeds in level flight. Range and endurance with thrust production, and power producing engines. Cruise techniques - constant angle of attack, constant Match number; constant altitude, methods- comparison of performance. The effect of alternative fuel flow laws, weight, altitude and temperature on cruise performance. Cruise performance with mixed power-plants

MODULE –III: CLIMB, DESCENT and MANOEUVRE PERFORMANCE (11)

Climb and descent techniques, safety considerations, performance analysis- maximum climb gradient, climb rate. Energy height and specific excess power, optimal climbs - minimum time, minimum fuel climbs. Measurement of climb performance. Descent performance in aircraft operations. Effect of wind on climb and descent performance.

Accelerated motion of aircraft - equations of motion- the manoeuvre envelope. Longitudinal manoeuvres- the pull-up, push over manoeuvres. Lateral manoeuvres- turn performance- turn rates, turn radius, limiting factors. Manouvre boundaries, Manoeuvre performance of military aircraft, transport aircraft.

MODULE –IV: TAKEOFF and LANDING (09)

Estimation of take-off distances. The effect on the take-off distance wrt weight, wind, runway conditions, ground effect. Take off safety factors, The estimation of landing distances, the discontinued landing, baulked landing air safety procedures and requirements on performance The effect on the landing distance, of weight, wind, runway conditions, ground effect. Fuel planning, fuel requirement, trip fuel, reserve and tankering.

MODULE –V: FLIGHT PERFORMANCE CONSIDERATIONS IN TACTICAL MISSILE DESIGN (09)

Flight performance envelope, Equations of motion modeling, driving parameters for flight performance, Cruise flight performance, Steady state flight, Flight trajectory shaping, Turn radius, Coast flight performance, Boost flight performance, Intercept lead angle and velocity, Comparison with performance requirements.

V. TEXT BOOKS:

1. Turner, M.J.L., “Rocket and Spacecraft Propulsion”, MIT Press, 2nd Edition, 2022.
2. Anderson, J.D. Jr., “Aircraft Performance and Design”, International edition McGraw Hill, 1st Edition, 1999, ISBN: 0-07-001971-1. 2. Eshelby, M.E., “Aircraft Performance theory and Practice”, AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1-56347-398-4.
3. Nelson, R.C, “Flight Stability and Automatic Control”, Tata McGraw Hill, 2nd Edition, 2007, ISBN 0-07-066110- 3.

VI. REFERENCE BOOKS:

1. McCormick, B.W, “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, 2nd Edition, 1995, ISBN: 0-471- 57506-2.
2. Yechout, T.R. et al., “Introduction to Aircraft Flight Mechanics”, AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1-56347-577-4.
3. Shevel, R.S., “Fundamentals of Flight”, Pearson Education, 2nd Edition, 1989, ISBN: 81-297-

0514-
4. Schmidt, L.V., “Introduction to Aircraft Flight Dynamics”, AIAA Education Series, 1st Edition, 1998, ISBN A56347-226-0.

VII. ELECTRONIC RESOURCES:

1. www.myopencourses.com/subject/flight-dynamics-i-airplane-performance.
2. www.scribd.com/doc/185026212/Introduction-to-Flight-Third-Edition-by-John-D-Anderson.Jr
3. www.scribd.com/book/282507871/Performance-and-Stability-of-Aircraft
4. www.scribd.com/doc/203462287/Aircraft-Performance-NPTEL
5. www.nptel.ac.in/courses/101106041

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation